Preliminary Matters

Referring to the objections to the drawings, and in particular the proposed drawing amendments filed April 27, 1999, Applicants submit herewith further proposed corrections believed to address the points raised by the Examiner. In particular, the inner cover layer has been labeled with a Shore D value of ≥ 45.

In addition, in the Amendment filed April 27, 1999, Applicants submitted a verified English translation of the priority document (JPA 7-171520) to perfect Applicants' claim to priority. In the Advisory Action of May 6, 1999, the Examiner acknowledged receiving the priority document, but it was indicated that the claim was not perfected, presumably because the translation was not earlier submitted.

Applicants respectfully submit that submission of the verified English translation of the priority document entitles Applicants to a date of invention of June 14, 1995. Each of the claims now presently pending in the application find support in the priority document, as can be found in the claim chart attached as Appendix B to the Request for Interference Pursuant to 37 C.F.R. § 1.607.

Rejection of Claims

Claims 1-19 are presently pending in the application. The Examiner has rejected these claims under 35 U.S.C. § 112, second paragraph, as being indefinite, and under § 103(a) as being unpatentable over Chikaraishi *et al.* (U.S. Patent No. 5,048,838) or Cavallaro *et al.* (U.S. Patent

No. 5,688,191) each in view of Nakamura. These rejections are respectfully traversed for the following reasons.

With respect to the § 112, second paragraph, rejection of the claims, Applicants find this rejection without any basis. The Examiner states that the subject matter of the invention is obscured by failing to illustrate every feature claimed on the drawings, but does not state what feature is claimed but not illustrated. Clarification is requested, to the extent the Examiner maintains this rejection. Applicants believe that a rejection on this basis is improper. The figures as amended and presented today clearly illustrate the pertinent features of the invention to the extent possible and practicable. Other claimed features, such as the composition of different layers or the thickness of different layers are not necessarily shown in the drawings but are clearly described in the specification and/or the tables. In this regard, Applicants believe that such features need not be shown if the general structure of the claimed golf ball is illustrated. Thus, Applicants respectfully request reconsideration and withdrawal of the § 112, second paragraph, rejection.

With respect to the Examiner's requirement that all Shore D values be expressed in Shore C parameters, Applicants believe this to be improper as well. Indeed, the prior art relied upon by the Examiner, Nakamura, uses Shore D values to indicate the hardness of the layers. In addition, U.S. Patent No. 5,743,816, a patent the Applicants seek to provoke an interference, also uses Shore D hardness values. It is thus quite common and customary that U.S. patents issue using the Shore D hardness value. Accordingly, Applicants respectfully traverse this portion of the

rejection to the extent the Examiner insists that the application be amended to express all Shore D values in terms of Shore C.

For the foregoing reasons, reconsideration and withdrawal of the § 112, second paragraph, rejection of the claims are respectfully requested.

Turning now to the prior art rejection of claims 1-19, Applicants respectfully traverse this rejection.

The Examiner only provides a brief statement as to how the combination of the prior art renders the claims obvious. The Examiner's statement that Nakamura renders obvious the claims because it provides each of the primary reference golf balls with a cover having a Shore D hardness of 60 fails to consider essentially all other features required by claims 1-19 and fails to consider why it would have been obvious to combine the teachings of Nakamura with Chikaraishi *et al.* or Cavallaro *et al.*

Chikaraishi *et al.* discloses a three-piece solid golf ball having a two-piece solid core consisting of an inner layer and an outer layer, and a cover enclosing the core. The two-piece solid core consists of the inner layer having a diameter in the range of 15-25 mm, a weight in the range of 5-12 gm, a specific gravity of 1.56-4, and a hardness in the range of 55-80 Shore C, and the outer layer has a lower specific gravity than that of the inner layer by 0.5-1.5. The cover has a radial thickness of 1.5-2.5 mm.

However, in contrast to the present invention, Chikaraishi *et al.* fails to disclose a four-piece golf ball. The cover of Chikaraishi *et al.* is a single layer, and thus Chikaraishi *et al.*

fails to disclose and teach that "a cover enclosing the core and consisting of inner and outer cover layers, where the outer cover layer has a hardness of 40-60° Shore D, and the inner cover layer has a hardness of up to 53° Shore D and lower than that of the outer cover layer."

Moreover, the core inner layer of Chikaraishi *et al.* has a diameter of 18-23 mm which is smaller than the diameter of 25-38 mm according to the inner sphere of the present invention.

Thus, Chikaraishi *et al.* is substantially different than the golf ball defined by the claims of the present application.

Cavallaro *et al.* discloses a golf ball including a core, a cover layer, and a mantle layer disposed between the core and the cover. The cover layer consists of one or more ionomer resins. The mantle layer includes a thermal plastic material consisting essentially of polyesther block copolymer. Although Cavallaro *et al.* discloses a two-layer cover, it fails to disclose and teach that the outer cover layer has a hardness of 40-60° Shore D, and the inner cover layer has a hardness of up to 53° on Shore D and lower than that of the outer cover layer. If, in contrast to the present invention, the inner cover layer is harder than that of the outer cover layer, the putting feel is inferior as is evident from Comparative Example 3 set forth in the present application.

Thus, Cavallaro *et al.*, like Chikaraishi *et al.*, fails to disclose substantial limitations of the claims.

Lastly, Nakamura discloses a golf ball including a core and a cover. The cover is a lithium neutralized ionomer resin which is a copolymer of 10-20% by weight of an alpha, beta-unsaturated carboxylic acid and the rest of ethylene, of which 20-70 carboylxol groups are

neutralized with lithium ion and the ionomer resin has as melt index of 0.8-3.0 and a Shore D hardness of 60-80.

Thus, Nakamura discloses merely a two-piece golf ball having a core and a cover. Nakamura has nothing in common with the golf ball disclosed in the present application, or for that matter anything in common with the primary references.

In sum, the references, alone and in combination, fail to disclose and teach a cover enclosing a core and having an outer cover layer, where the outer cover layer has a hardness of 40-60° Shore D, and said inner cover layer has a hardness of up to 53° Shore D and lower than that of said outer cover layer.

Furthermore, there is no teaching or even suggestion in any of the prior art references that would motivate one of ordinary skill in the art to combine the selective teachings of prior art, if even possible, to render the present application unpatentable. It is therefore respectfully submitted that claims 1-19 are patentable over the applied prior art.

For all of the foregoing reasons, Applicants respectfully requests for the reconsideration and withdrawal of the rejection of claims 1-19.

Lastly, Applicants are submitting herewith a request pursuant to 37 C.F.R. § 1.607, seeking to provoke an interference between the claims of the present application and those in the '816 patent. Should the Examiner have any questions regarding this application, he is respectfully requested to contact the Applicants' representative at the local telephone exchange listed below.

Applicant hereby petitions for any extension of time which may be required to maintain the pendency of this case, and any required fee, except for the Issue Fee, for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,

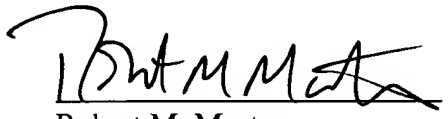

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FIG.1

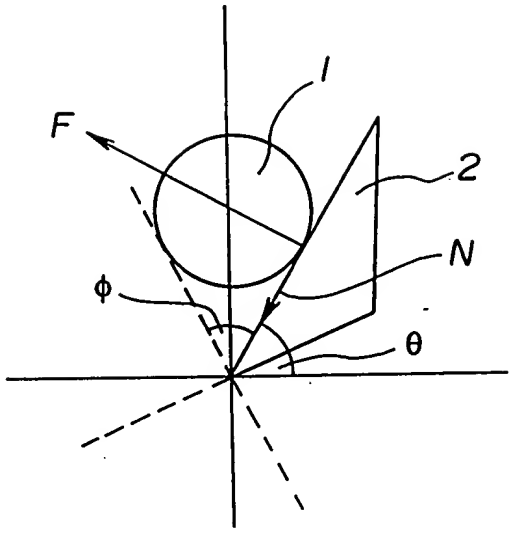
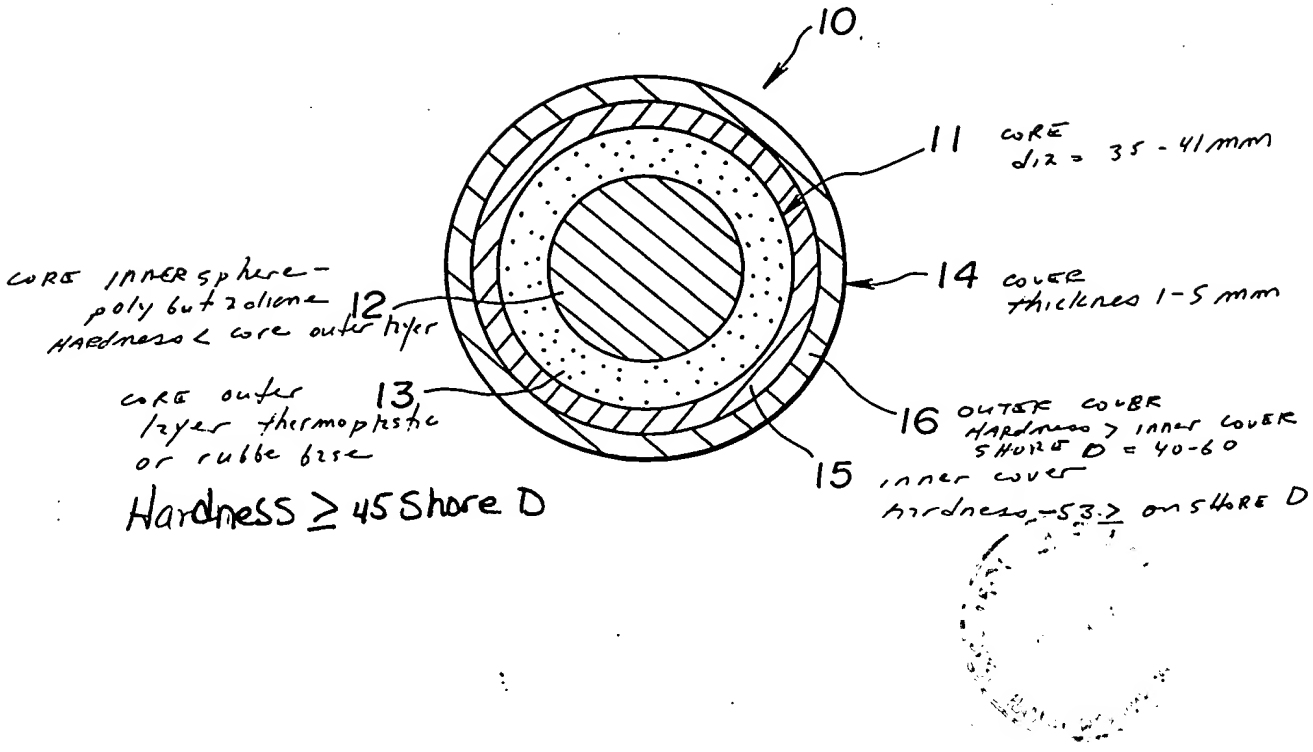

1
F
2
N
ϕ
θ

FIG.2


10
11 CORE dia = 35 - 41 mm
14 COVER thickness 1-5 mm
CORE INNER sphere - poly butadiene 12
HARDness < core outer layer
CORE outer layer thermoplastic or rubber base 13
Hardness ≥ 45 Shore D
16 OUTER COVER HARDness > INNER COVER SHORE D = 40-60
15 INNER COVER hardness - 53 ≥ on SHORE D

C E R T I F I C A T I O N

I, Takashi KOJIMA of Ginza Ohtsuka Bldg., 2F, 16-12, Ginza 2-chome, Chuo-ku, Tokyo, Japan, hereby certify that I am the translator of the accompanying certified official copy of the documents in respect of an application for a patent filed in Japan on the 14th of June, 1995 and of the official certificate attached thereto, and certify that the following is a true and correct translation to the best of my knowledge and belief.

Dated this 26th day of April, 1999

Takashi Kojima

Takashi KOJIMA

(Translation)

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application : June 14, 1995

Application Number : Japanese Patent Application No. 7-171520

Applicant(s) : Bridgestone Sports Co., Ltd.

February 2, 1996

Commissioner,
Patent Office Yuji KIYOKAWA
(sealed)

Certificate No. 8-3000378

7-171520

[Paper] APPLICATION FOR PATENT

[Reference Number] 7070

[Application Date] June 14, 1995

[Destination] The Commissioner of the Patent Office
Akira TAKASHIMA

[International Patent Classification]
A63B 37/00
B32B 25/04

[Title of the Invention] Multi-Piece Solid Golf Ball

[Number of the Claims] 4

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[Official Fee]
[Method for Paying] Deposit
[Deposit Account Number] 003207
[Amount of Fee] 21000

[List of Documents Attached]
[Document] Specification 1
[Document] Drawing 1
[Document] Abstract 1
[General Power of Attorney Number] 9300681

7-171520

[SPECIFICATION]

[TITLE OF THE INVENTION] Multi-Piece Solid Golf Ball

[CLAIMS]

[Claim 1] A multi-piece solid golf ball having a structure of at least four layers, said ball comprising a core having a structure consisting of at least two layers and a cover enclosing the core and consisting of two layers, an outer cover layer having a hardness of 40 to 60 degrees on Shore D, and an inner cover layer having a hardness of up to 53 degrees on Shore D and lower than that of said outer cover layer.

[Claim 2] The golf ball of claim 1 wherein said inner cover layer is softer than said outer cover layer by a hardness difference of at least 5 degrees on Shore D.

[Claim 3] The golf ball of claim 1 or 2 wherein said outer cover layer has a gage of 0.5 to 3.0 mm, said inner cover layer has a gage of 0.5 to 3.0 mm, and the entire cover has a gage of 1.0 to 5.0 mm.

[Claim 4] The golf ball of any one of claims 1 to 3 wherein said core consists of an inner sphere and a layer surrounding the inner sphere, said inner sphere has a diameter of 20 to 39 mm and is formed of a rubber base material to a hardness of 20 to 55 degrees on Shore D, said surrounding layer has a hardness of at least 45 degrees on Shore D, and said core has a diameter of 35 to 41 mm.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Industrial Field]

This invention relates to a multi-piece solid golf ball having a structure of at least four layers. Particularly, it relates to a multi-piece solid golf ball which is improved in flying performance, hitting feel and controllability and has an excellent durability.

[0002]

[Prior Art and Problem to be Solved by the Invention]

Golf balls of the thread wound balata structure have been long favored by many professional golfers and skilled

golfers. The wound golf balls are superior in feeling and controllability which are essential factors for skilled golfers. Because of their structure that is receptive to more spin, however, the wound golf balls are less controllable in flying distance. That is, when the ball is hit against the wind, it tends to fly sharply high, failing to travel a satisfactory carry. When the ball is hit into fair winds, it will travel a more distance than intended.

[0003]

Recently, two-piece solid golf balls designed for adequate spin are considered acceptable by some skilled golfers. The absolute difference from the wound golf balls still resides in spin receptivity since the two-piece solid golf balls are characterized by a lower spin rate. As compared with the wound golf balls, the two-piece solid golf balls are superior with respect to the carry and improved in straight flight due to a low spin rate, but upon long iron shots requiring controllability, they tend to fly too much, indicating a loss of control. With respect to feel, the two-piece solid golf balls are approaching to the wound golf balls with room for improvement being still left.

[0004]

The present invention has been accomplished in view of the above situation, and an object of the present invention is to provide a multi-piece solid golf ball which will travel a satisfactory carry as inherent to solid golf balls when shot with a driver, receives more spin when shot with an iron, and has controllability closer to the wound balata golf ball.

[0005]

[Means to Solve the Problem and Action]

To attain the above object, the present invention provides a multi-piece solid golf ball having a structure of at least four layers, comprising a core having a structure consisting of at least two layers and a cover enclosing the core and consisting of two layers. The outer cover layer has a hardness of 40 to 60 degrees on Shore D. The inner

cover layer has a hardness of up to 53 degrees on Shore D and lower than that of the outer cover layer.

[0006]

The mechanism how the golf ball spins is now considered. The factors that determine spin include the loft of a club, the relation of an impact point to the center of gravity, and the head speed of the club. Since the latter two factors are correlated to the club configuration and the player's ability, it is now assumed that these factors are fixed. Only the club loft is now considered. A model diagram upon impact is shown in FIG. 1. In FIG. 1, 1 is a golf ball and 2 is a golf club. ϕ is a static loft of the club and θ is a dynamic impact loft. F is a component of force perpendicular to the club face and N is a component of force parallel to the club face. The perpendicular component of force F and the parallel component of force N with respect to the club face have the relation: $F/N = \tan\theta$. Since the impact loft θ decreases as the club loft ϕ increases, the value of $(F/N)_D$ associated with the use of a driver having a certain club loft is greater than the value associated with the use of a club having a larger club loft, typically $(F/N)_{SW}$ associated with the use of a sand wedge, that is, $(F/N)_D > (F/N)_{SW}$.

[0007]

The ball is deformed by the force F perpendicular to the club face and spun by the force N parallel to the club face. Since a two-piece solid golf ball restitutes from the deformation at a higher rate as compared with the wound golf ball, the ball leaves the club face before a sufficient spin is imparted. This is generally known as a slip phenomenon which accounts for the poor spin receptivity of the conventional two-piece solid golf ball as compared with the wound golf ball.

[0008]

To produce a spin sufficient for adequate control, a frictional force must act between the golf ball and the club face. This requires to use a relatively soft cover material. Nevertheless, the conventional solid golf balls cannot fully suppress the above-mentioned slip phenomenon.

[0009]

As defined above, the golf ball of the invention uses a two-layer cover wherein the outer cover layer has a hardness of 40 to 60 degrees on Shore D and the inner cover layer has a hardness of up to 53 degrees on Shore D and lower than that of the outer cover layer. Differently stated, inside a soft outer cover layer is formed a softer inner cover layer. This is one of the features of the invention. When the ball wherein the inner cover layer which is softer than the outer cover layer lies inside the outer cover layer which is soft in itself is subject to a driver shot providing a great value of F/N indicating that the perpendicular force F is greater than the parallel force N, a compressive force acts on the inner cover layer to a greater extent and a force in a shearing direction is smaller than the compressive force. Since soft layers are provided in the compression direction, the feel upon hitting is very soft and comparable to the feel of the wound balata golf ball. In addition, since the force in the shearing direction is small, the reaction force at the same site is small enough to restrain too much spinning. This ensures a low spin, flat and long-extending ball trajectory and carry that solid golf balls inherently possess.

[0010]

On the other hand, when a club having a greater loft is used, the force in a shearing direction increases relative to the compressive force. Since the inner cover layer is formed as a softer layer, the amount of local deformation in a shearing direction increases in response to the shearing force. This restrains the slip phenomenon which is the drawback of solid golf balls. The resultant spin performance is approximate to that of the wound golf ball

rather than the prior art solid golf balls designed in pursuit of spin performance. Thus the ball can respond to an intentional shot.

[0011]

In addition to the structure that the cover consists of two layers, the golf ball of the invention is structured as consisting of at least four layers since the core consists of at least two layers. The ball thus has improved restitution or repulsion. More particularly, the use of a soft material as a ball component generally tends to lower restitution to reduce a carry. By forming the core as a multi-layer structure having two or more layers, restitution is improved due to the embracement effect of the respective layers as compared with a single layer structure core of the same softness, ensuring a satisfactory carry. The multi-layer core consisting of an inner sphere and a layer surrounding the inner sphere wherein the inner sphere is formed softer than the surrounding layer is improved in hitting feel or affords a softer hitting feel.

[0012]

As mentioned above, the golf ball comprising at least four layers wherein the cover has a two layer structure consisting of a soft outer cover layer and a softer inner cover layer provides spin performance approximate to that of the wound golf ball rather than the prior art solid golf balls designed in pursuit of spin performance while maintaining the flying performance inherent to solid golf balls. That is, there is obtained a golf ball which has advantages of solid golf balls and wound golf balls.

[0013]

The following is the detailed description of the invention. The golf ball of the present invention is a multi-piece solid golf ball which comprises a core having a structure consisting of at least two layers and a cover enclosing the core and consisting of two layers, an outer cover layer having a Shore D hardness of 40 to 60 degrees, and an inner cover layer having a Shore D hardness of up to 53 degrees and lower than that of the outer cover layer.

[0014]

Referring to FIG. 2, there is illustrated one exemplary structure of the golf ball. The ball 10 includes a solid core 11 consisting of an inner sphere 12 and a layer 13 surrounding the inner sphere and a cover 14 around the core consisting of inner and outer cover layers 15 and 16. The surrounding layer 13 may be a single layer or have a plurality of layers. In the former case, the golf ball is of the four layer structure.

[0015]

The outer cover layer 16 is formed to a hardness of 40 to 60 degrees, preferably 40 to 58 degrees on Shore D. With a hardness of less than 40 degrees, the ball is reduced in restitution, failing to provide satisfactory flying performance. With a hardness of more than 60 degrees, the frictional force between the golf ball and the club face is reduced to induce the so-called slip phenomenon, failing to provide sufficient controllability. The inner cover layer 15 has a hardness of up to 53 degrees, preferably up to 50 degrees on Shore D. If the inner cover layer hardness exceeds 53 degrees, the amount of local deformation in a shearing direction can be reduced to induce the slip phenomenon when a club having a greater loft is used. The inner cover layer 15 should preferably have a hardness of at least 30 degrees on Shore D in order to provide restitution for the ball.

[0016]

The inner cover layer 15 should be formed softer than the outer cover layer 16. The objects of the invention are not achieved if the inner cover layer 15 is harder than the outer cover layer 16. It is recommended for the objects of the invention that the inner cover layer is softer than the outer cover layer by a hardness difference of at least 5 degrees, more preferably 5 to 30 degrees, most preferably 5 to 20 degrees on Shore D.

[0017]

The outer cover layer 16 has a gage (or radial thickness) of 0.5 to 3.0 mm, more preferably 1.0 to 2.3 mm,

the inner cover layer 15 has a gage of 0.5 to 3.0 mm, more preferably 1.0 to 2.0 mm. The entire cover 14 preferably has a gage of 1.0 to 5.0 mm, especially 2.0 to 4.0 mm. If the outer cover layer 16 is too thin, the ball would be less durable. If the outer cover layer is too thick, restitution would be lost. If the inner cover layer 15 is too thin, the local deformation in a shearing direction would be reduced, failing to suppress the slip phenomenon. If the inner cover layer is too thick, restitution would be lost. If the entire cover 14 is too thin, the ball would be less durable and poor in feel. If the entire cover is too thick, the ball would lose restitution, failing to provide satisfactory flying performance.

[0018]

The inner and outer cover layers 15 and 16 may be formed to the above-defined hardness using thermoplastic resins such as ionomer resins and non-ionomer resins alone or in admixture.

[0019]

In the core 11, the inner sphere 12 preferably has a Shore D hardness of 20 to 55 degrees, especially 25 to 50 degrees and a distortion of 2.6 to 8.7 mm, especially 3.5 to 7.7 mm under a load of 100 kg. If the inner sphere 12 has a too low hardness, restitution would be lost, failing to provide satisfactory flying performance. If the inner sphere has a too high hardness, the feel would be exacerbated. The inner sphere 12 should preferably have a diameter of 20 to 39 mm, especially 25 to 38 mm since it has a substantial influence on the feel upon driver shots.

[0020]

Like the core of prior art two-piece solid golf balls, the inner sphere 12 may be formed of a rubber material based on polybutadiene which is vulcanized with an organic peroxide with the aid of a crosslinking agent such as zinc (meth)acrylate.

[0021]

The surrounding layer 13 around the inner sphere 12 preferably has a hardness of at least 45 degrees, more

preferably at least 55 degrees on Shore D. If the surrounding layer's hardness is less than 45 degrees, restitution would be reduced. For providing a better feel, the surrounding layer should preferably have a hardness of up to 80 degrees, more preferably up to 75 degrees on Shore D. It is preferred that the hardness of the surrounding layer 13 be greater than the hardness of the inner cover layer 15 and that the hardness of the surrounding layer 13 be greater than the hardness of the inner sphere 12 for compensating for the short restitution of the very soft inner sphere 12.

[0022]

Preferably the surrounding layer 13 has a gage of 1.0 to 10 mm, especially 1.0 to 8 mm and the core 11 has a diameter of 35 to 41 mm, especially 36 to 40 mm. If the surrounding layer 13 is too thin, restitution would be insufficient. If the surrounding layer is too thick, the hitting feel would be exacerbated.

[0023]

The surrounding layer 13 may be formed mainly of thermoplastic resins such as ionomer resins or rubber base materials like the inner sphere 12.

[0024]

In the practice of the invention, the material and preparation of the core are not critical. Any of well-known materials and methods may be used insofar as the above-mentioned golf ball properties are achievable.

[0025]

More particularly, the inner sphere of the core of the golf ball according to the invention may be prepared by a conventional technique while properly adjusting vulcanizing conditions and formulation. Usually the formulation of the inner sphere includes a base rubber, a crosslinking agent, a co-crosslinking agent, and an inert filler. The base rubber may be selected from natural rubber and synthetic rubbers used in conventional solid golf balls. The preferred base rubber is 1,4-polybutadiene having at least 40% of cis-structure in the present invention. The polybutadiene may

be blended with natural rubber, polyisoprene rubber, styrene-butadiene rubber or the like.

[0026]

Examples of the crosslinking agent include organic peroxides such as dicumyl peroxide and di-t-butyl peroxide, and especially dicumyl peroxide is preferred. Usually 0.5 to 1.0 part by weight of the crosslinking agent is blended with 100 parts by weight of the base rubber.

[0027]

Examples of the co-crosslinking agent include metal salts of unsaturated fatty acids, inter alia, zinc and magnesium salts of unsaturated fatty acids having 3 to 8 carbon atoms (e.g., acrylic acid and methacrylic acid) though not limited thereto. Zinc acrylate is especially preferred. 5 to 40 parts by weight of the co-crosslinking agent is blended with 100 parts by weight of the base rubber.

[0028]

Examples of the inert filler include zinc oxide, barium sulfate, silica, calcium carbonate, and zinc carbonate, with zinc oxide and barium sulfate being often used. The amount of the filler is not limited since the amount depends on the specific gravity of the core and the cover and the weight standard of the ball. Usually, the amount of the filler blended is preferably 10 to 100 parts by weight per 100 parts by weight of the base rubber. In the practice of the invention, the amount of the filler (typically zinc oxide and barium sulfate) is properly selected so as to provide the desired hardness to the inner sphere.

[0029]

An inner sphere-forming composition is prepared by kneading the above-mentioned components in a conventional mixer such as a Banbury mixer and roll mill, and it is compression or injection molded in an inner sphere mold. The molding is then cured by heating at a sufficient temperature for the crosslinking agent and co-crosslinking agent to function (for example, a temperature of about 130 to 170°C for a combination of dicumyl peroxide as the

crosslinking agent and zinc acrylate as the co-crosslinking agent), obtaining an inner sphere.

[0030]

Where the core consists of an inner sphere and a single surrounding layer, the inner sphere may be formed of a composition as described above and the surrounding layer may be formed of a composition similar to the composition used for the inner sphere or another resin composition based on an ionomer resin or the like. The surrounding layer can be formed on the inner sphere by compression molding or injection molding. Where more than one surrounding layer is included, they may be similarly formed.

[0031]

The golf ball of the invention is prepared in accordance with the Rules of Golf, that is, to a diameter of at least 42.67 mm and a weight of not greater than 45.93 grams. The golf ball preferably has a distortion of 2.5 to 4.0 mm, especially 2.6 to 3.5 mm under a load of 100 kg.

[0032]

[Effect of the Invention]

A multi-piece solid golf ball of the invention will travel a distance comparable to conventional solid golf balls and have spin receptivity approximate to wound golf balls and is improved in durability and feel.

[0033]

[EXAMPLE]

Examples and Comparative Examples are given below by way of illustration of the present invention, although the present invention is not limited thereto.

[0034]

[Examples & Comparative Examples]

Golf balls as shown in Table 1 were prepared by the following procedure.

Inner sphere

An inner sphere having a hardness as reported in Table 1 was prepared by milling the components shown below in a roll mill and compression molding it in a mold at 155°C for 15 minutes.

Formulation	Parts by weight
1,4-polybutadiene (cis structure)	100
Zinc acrylate	15-30
Dicumyl peroxide	0.9
Anti-oxidant	0.2
Zinc oxide	5
Barium sulfate	15-40

Surrounding layer

In the case of a rubber base material, components as used for the inner sphere were milled in a roll mill, molded into half shells in semi-vulcanized state. The inner sphere was enclosed with the half shells, which were compression molded again at 155°C for 15 minutes, yielding a core (Examples 6 and 7).

In the case of a thermoplastic resin, Hytrel 5557, Himilan 1706 or Himilan 1706/1605 = 50/50 was injection molded over the inner sphere to yield a core (Examples 1 to 5).

Inner cover layer

Hytrel 4047, Hytrel 4767 or Hytrel 5612JB was injection molded over the surrounding layer to form an inner cover layer as reported in Table 1.

Outer cover layer

A blend of Himilan 1650/Surlyn 8120 was injection molded over the inner cover layer to form an outer cover layer as reported in Table 1.

[0035]

The thus obtained golf balls were examined for spin, carry, total distance, and feel by hitting the balls with a driver (#W1) at a head speed (HS) of 45 m/sec. The golf balls were also examined for spin and launch angle by hitting the balls with a sand wedge at a head speed of 19 m/sec. The golf balls were further examined for spin, carry, and total distance by hitting the balls with No. 7 iron at a head speed of 38 m/sec. Using a putter, the golf balls were also examined for putting feel. The results are shown in Table 1.

Three professional golfers who swung at a head speed of 45 to 48 m/sec. actually hit the golf balls to examine their hitting feel. The ball was rated "◎" when it was felt very soft, "O" when soft, "Δ" when a little hard, and "X" when hard.

[0036]

[Table 1]

	E1	E2	E3	E4	E5	E6	E7	CE 1	CE 2	CE 3	CE 4
Inner sphere											
Diameter (mm)	35.30	35.30	33.90	33.50	35.30	30.00	27.00	38.50	38.50	36.50	
Shore D	47	45	40	45	45	35	29	45	53	49	
Surrounding layer											
Diameter (mm)	37.90	37.90	37.90	36.10	37.90	37.90	37.70	-	-	-	Commercially
Shore D	68	73	68	68	68	65	65	-	-	-	available
Inner cover layer											wound
Gage (mm)	1.25	1.25	1.25	1.50	1.25	1.00	1.50	-	-	1.60	balata
Shore D	40	45	40	40	35	40	35	-	-	68	ball
Outer cover layer											
Gage (mm)	1.15	1.15	1.15	1.80	1.15	1.40	1.00	2.10	2.10	1.50	
Shore D	47	51	51	55	47	53	43	65	53	55	
Ball											
Diameter (mm)	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	42.70	
Hardness*	2.90	2.85	3.10	2.80	3.20	2.75	2.85	2.80	2.40	2.40	
#W1/HS45											
Spin (rpm)	2980	2870	2810	2920	3010	2790	2880	2690	2850	2870	3255
Carry (m)	210.8	211.3	210.2	210.6	210.7	211.1	210.8	208.2	208.7	210.3	207.9
Total (m)	224.6	225.3	224.3	224.5	224.2	225.5	224.8	223.1	223.5	224.3	221.6
Feel	O	O	◎	O	O	◎	◎	O	X	O	◎
#SW/HS19											
Spin (rpm)	6020	5770	5810	5580	6080	5760	6160	4130	5670	5920	6070
Launch angle (°)	30.0	30.6	30.4	31.1	29.8	30.6	29.6	34.3	30.8	30.2	29.8
#I7/HS38											
Spin (rpm)	6450	6370	6300	6280	6350	6400	6500	5200	5450	5340	6450
Carry (m)	151.4	151.8	151.9	152.0	151.6	151.9	151.0	156.7	156.0	156.0	151.2
Total (m)	151.6	152.0	152.5	152.5	152.0	152.1	151.0	160.2	159.1	160.0	151.5
Putt											
Feel	◎	O	O	O	◎	O	◎	X	Δ	X	O

* a distortion (mm) under a load of 100 kg

[BRIEF DESCRIPTION OF THE DRAWINGS]

[FIG. 1]

FIG. 1 schematically illustrates a club striking a ball upon impact.

[FIG. 2]

FIG. 2 is a schematic cross section of one exemplary golf ball according to the invention.

[Explanation of Reference Number]

10 Golf ball
11 Core
12 Inner sphere
13 Surrounding layer
14 Cover
15 Inner cover
16 Outer cover

[ABSTRACT]

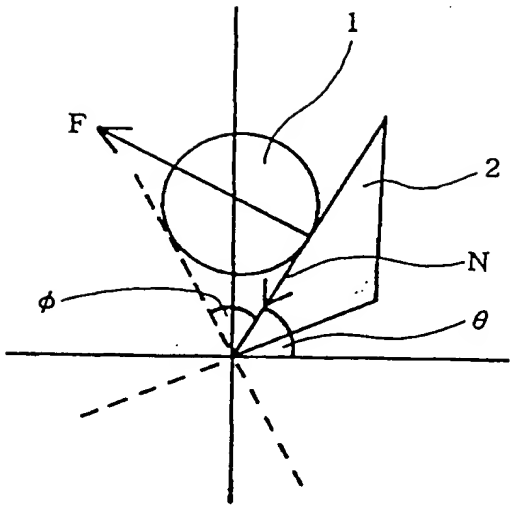
[Constitution] A multi-piece solid golf ball comprises a core having a structure consisting of at least two layers and a cover on the core consisting of two layers. An outer cover layer has a Shore D hardness of 40-60 degrees. An inner cover layer has a Shore D hardness of up to 53 degrees and lower than that of the outer cover layer.

[Effect] The ball's carry is comparable to conventional solid golf balls and spin receptivity is approximate to wound golf balls while the ball is durable and offers pleasant feel.

[Selected Drawing] FIG. 2

[Drawing]

[Fig. 1]



[Fig. 2]